

**REMARKS**

Claims 1-7, 9-11, 13-18, 22-41 and 82-83 are pending in this application. Claims 1, 22 and 82-83 have been amended. Claims 30-32, 36-38 and 84-86 have been canceled. Claims 87-93 have been added.

Claims 1, 6, 7, 9, 10, 22, 27-29 and 82 stand rejected under 35 U.S.C. § 102(b) as being anticipated by Yutaka (JP 58207009) ("Yutaka"). The rejection is respectfully traversed.

The claimed invention is a non-aqueous etching mixture which consists essentially of an alcohol in combination with at least two inorganic acids. As such, amended independent claim 1 recites an etching composition consisting essentially of "a non-aqueous composition of an alcohol and at least two inorganic acids, wherein one of said inorganic acids is selected from the group consisting of hydrofluoric acid, phosphoric acid, sulfuric acid, boric acid, carbonic acid, perchloric acid and sulfurous acid." Independent amended claim 22 also recites an etching composition consisting essentially of "a non-aqueous composition of an alcohol and at least two different inorganic acids selected from the group consisting of hydrofluoric acid, phosphoric acid, sulfuric acid, boric acid, carbonic acid, perchloric acid and sulfurous acid." Independent amended claim 82 further recites an etching composition consisting essentially of "a non-aqueous composition of isopropanol and at least two inorganic acids, wherein one of said inorganic acids is selected from the group consisting of hydrofluoric acid, phosphoric acid, sulfuric acid, boric acid, carbonic acid, perchloric acid and sulfurous acid."

Yutaka does not disclose the limitations of the subject matter of claims 1, 6, 7, 9, 10, 22, 27-29 and 82. Yutaka discloses "a liquid mixture consisting of HBr, HNO<sub>3</sub> and alcohol (e.g.; methanol, ethanol, etc)" for etching "in the stage of forming positive type photoresist of a prescribed pattern on a semiconductor substrate of InP or Ga<sub>x</sub>In<sub>1-x</sub>As<sub>y</sub>P<sub>1-y</sub>"

(Abstract). Yutaka does not disclose a composition consisting essentially of “a non-aqueous composition of an alcohol and at least two inorganic acids, wherein one of said inorganic acids is selected from the group consisting of hydrofluoric acid, phosphoric acid, sulfuric acid, boric acid, carbonic acid, perchloric acid and sulfurous acid,” as amended independent claim 1 recites, or consisting essentially of “a non-aqueous composition of an alcohol and at least two different inorganic acids selected from the group consisting of hydrofluoric acid, phosphoric acid, sulfuric acid, boric acid, carbonic acid, perchloric acid and sulfurous acid,” as amended independent claim 22 recites. Yutaka also fails to disclose an etching composition consisting essentially of “a non-aqueous composition of isopropanol and at least two inorganic acids selected from the group consisting of hydrofluoric acid, phosphoric acid, sulfuric acid, boric acid, carbonic acid, perchloric acid and sulfurous acid,” as amended independent claim 82 recites. Accordingly, Yutaka does not disclose the limitations of claims 1, 6, 7, 9, 10, 22, 27-29 and 82 and the subject matter of these claims is not anticipated by Yutaka under 35 U.S.C. § 102(b).

Claims 2-5, 11, 23-26 and 83 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Yutaka (JP 58207009) (“Yutaka”) as applied to claims 1 and 22. The rejection is respectfully traversed.

The claimed invention teaches an etching mixture which consists essentially of a non-aqueous composition of an alcohol in combination with two inorganic acids. As such, dependent claims 2 and 23 recite that the alcohol is “a polyhydric alcohol,” while dependent claims 3 and 24 recite “ethylene glycol, propylene glycol, butylene glycol, dipropylene glycol, sorbitol, hexylene glycol, 1,3-dibutylene glycol, 1,2,6-hexanetriol and 1,5-pentanediol” as choices for the polyhydric alcohol. Dependent claims 5 and 26 further recite that the alcohol is propylene glycol, while dependent claim 11 recites propylene glycol in a composition for etching including nitric acid and hydrofluoric acid.

Claims 5 and 11 depend on independent claim 1 which, as amended, recites an etching composition consisting essentially of “a non-aqueous composition of an alcohol and at least two inorganic acids, wherein one of said inorganic acids is selected from the group consisting of hydrofluoric acid, phosphoric acid, sulfuric acid, boric acid, carbonic acid, perchloric acid and sulfurous acid.” Claim 26 depends on claim 22, which recites an etching composition consisting essentially of “a non-aqueous composition of an alcohol and at least two different inorganic acids selected from the group consisting of hydrofluoric acid, phosphoric acid, sulfuric acid, boric acid, carbonic acid, perchloric acid and sulfurous acid.” Independent claim 83 further recites an etching composition which consists essentially of “a non-aqueous composition of propylene glycol and at least two inorganic acids, wherein one of said inorganic acids is selected from the group consisting of hydrofluoric acid, phosphoric acid, sulfuric acid, boric acid, carbonic acid, perchloric acid and sulfurous acid.”

The subject matter of claims 2-5, 11, 23-26 and 83 would not have been obvious over Yutaka because, contrary to the assertion of the Office Action, it would have been irrelevant if one skilled in the art would have “employ[ed] a conventional solvent such as propylene glycol for the purpose of producing an effective etchant.” (Office Action at 2). Yutaka does not disclose, teach or suggest the inorganic acids of the etching compositions of independent amended claims 1, 22 and 83. Yutaka discloses only HBr and  $\text{HNO}_3$  for etching “specific semiconductor substrate” such as InP or  $\text{Ga}_x\text{In}_{1-x}\text{As}_y\text{P}_{1-y}$ . Thus, even if one skilled in the art would have used propylene glycol, for example, “for the purpose of producing an effective etchant” as the Office Action asserts, the resultant etchant would still not consist essentially of “a non-aqueous composition of an alcohol and at least two inorganic acids, wherein one of said inorganic acids is selected from the group consisting of hydrofluoric acid, phosphoric acid, sulfuric acid, boric acid, carbonic acid, perchloric acid and sulfurous acid” (claims 1 and 83) or of “a non-aqueous composition of an alcohol and at least two different inorganic acids selected from the group consisting of

hydrofluoric acid, phosphoric acid, sulfuric acid, boric acid, carbonic acid, perchloric acid and sulfurous acid” (claim 22). Accordingly, the subject matter of claims 2-5, 11, 23-26 and 83 would not have been obvious over Yutaka and the rejection of the above-mentioned claims is respectfully requested.

Claims 13-18 and 33-35 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Yutaka (JP 58207009) (“Yutaka”) as applied to claims 1 and 22. The rejection is respectfully traversed.

The claimed invention teaches an etching mixture which consists essentially of a non-aqueous composition of an alcohol, such as a polyhydric alcohol, in combination with at least two inorganic acids. As such, dependent claims 13 and 33 recite that the ratio of alcohol to a first acid to a second acid is of about 10-50:5-40:1, while dependent claims 15 and 35 further limit such ratio to about 30:20:1. Similarly, dependent claim 16 recites a ratio of propylene glycol to nitric acid to hydrofluoric acid of about 10-50:5-40:1, while dependent claims 17 and 18 further limit such ratio to about 20-40:10-30:1 and 30:20:1, respectively.

The subject matter of claims 13-18 and 33-35 would not have been obvious over Yutaka. First, Yutaka is silent about any ratio of hydrogen bromide to nitric acid, or about any ratio of alcohol to hydrogen bromide to nitric acid. Second, the crux of Yutaka is a liquid mixture consisting only of HBr, HNO<sub>3</sub> and alcohol for etching either InP or Ga<sub>x</sub>In<sub>1-x</sub>As<sub>y</sub>P<sub>1-y</sub> to form “periodic ruggedness on the semiconductor substrate.” (Abstract). Yutaka does not teach or suggest an etching composition consisting essentially of “a non-aqueous composition of an alcohol and at least two inorganic acids, wherein one of said inorganic acids is selected from the group consisting of hydrofluoric acid, phosphoric acid, sulfuric acid, boric acid, carbonic acid, perchloric acid and sulfurous acid” (claim 1) or of “a non-aqueous composition of an alcohol and at least two different inorganic acids selected from the group consisting of hydrofluoric acid, phosphoric acid, sulfuric acid, boric acid,

carbonic acid, perchloric acid and sulfurous acid" (claim 22). Accordingly, the subject matter of claims 13-18 and 33-35 would not have been obvious over Yutaka and the rejection of these claims is respectfully requested.

Claims 39-41 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Mitsubishi Electric Corp. (JP 0048816) ("Mitsubishi"). The rejection is respectfully traversed.

The claimed invention recites a non-aqueous etching composition which consists essentially of an alcohol in combination with at least two inorganic acids. As such, independent claim 39 recites "a non-aqueous composition comprising propylene glycol, nitric acid and hydrofluoric acid" in a ratio of 10-50:5-40:1 for selectively etching doped polysilicon to undoped polysilicon. The ratio of propylene glycol to nitric acid to hydrofluoric acid is further defined in claims 40 and 41 as of about 20-40:10-30:1 and 30:20:1, respectively.

Mitsubishi discloses an aqueous etchant for silicon, and not a non-aqueous etchant ("aqueous hydrogen fluoride nitric acid organic compound" and "[E]tchant for silicon with minimal undercutting - of aq. hydrogen fluoride and nitric acid" - in the title). The aqueous etchant of Mitsubishi includes an acid with viscosity higher than that of water, such as phosphoric acid, or an anionized organic compound with viscosity higher than that of water, such as ethylene glycol or glycerol, in addition to hydrogen fluoride (HF) and nitric acid (HNO<sub>3</sub>) (Abstract). According to Mitsubishi, the addition of phosphoric acid, which has a much higher viscosity than that of water, to the aqueous etching solution increases the viscosity of the etching liquid, which in turn is prevented from entering narrow gaps in a silicon semiconductor device (Abstract). In accordance with the data offered by Mitsubishi, an etching solution containing 1 part of 50% HF solution and 40 parts of HNO<sub>3</sub> (by volume) results in a side etching of silicon of about 0.7-0.8  $\mu$ m for 1  $\mu$ m etching. When, however, 20 parts of HNO<sub>3</sub> are replaced with a substance

with viscosity higher than that of water, the side etching of silicon decreases. This way, an etching solution containing 1 part of 50% HF solution, 20 parts of  $\text{HNO}_3$  and 20 parts of  $\text{H}_3\text{PO}_4$  (by volume) gives a side etching of only 0.5  $\mu\text{m}$ .

The subject matter of claims 39-41 would not have been obvious over Mitsubishi. First, Mitsubishi expressly recites an aqueous solution, while independent claim 39 recites a non-aqueous composition. Second, Mitsubishi is silent about any ratio of hydrogen fluoride to nitric acid, or any ratio of propylene glycol to nitric acid to hydrofluoric acid. Third, Mitsubishi is silent about using propylene glycol, or using propylene glycol at  $35^\circ\text{C}$ , on doped and undoped polysilicon. Fourth, the crux of Mitsubishi is raising the viscosity of the aqueous etching solution, by adding, for example, phosphoric acid instead of half of the nitric acid. For this, Mitsubishi teaches, for example, a mixed liquid of 50% HF solution with  $\text{HNO}_3$  20 parts by volume and  $\text{H}_3\text{PO}_4$  20 parts by volume, which improved the viscosity of the etching solution. If 20 parts of  $\text{HNO}_3$  in Mitsubishi would be replaced with ethylene glycol or glycerol, the ratio of alcohol to nitric acid to hydrofluoric acid would be of about 1:1:(1/40), which is different than the ratio of the claimed invention, that is of about 10:5:1 to about 50:40:1. Accordingly, the subject matter of claims 39-41 would not have been obvious over Mitsubishi and withdrawal of this rejection is thus respectfully requested.

New claims 87-93 have been added to round out the scope of protection afforded by the invention. The cited references fail to teach or suggest the subject matter of these claims, including an etching composition which consists essentially of "a non-aqueous composition of an alcohol, hydrofluoric acid, and at least another inorganic acid" (claim 87), or of "a non-aqueous composition of an alcohol, phosphoric acid, and at least another inorganic acid" (claim 88), or of "a non-aqueous composition of an alcohol, sulfuric acid, and at least another inorganic acid" (claim 89). The cited references also fail to teach or suggest an etching composition which consists essentially of "a non-aqueous composition of an alcohol, boric acid, and at least another inorganic acid" (claim 90) or of

“a non-aqueous composition of an alcohol, perchloric acid, and at least another inorganic acid” (claim 91), or of “a non-aqueous composition of an alcohol, carbonic acid, and at least another inorganic acid” (claim 92), or of “a non-aqueous composition of an alcohol, sulfurous acid, and at least one inorganic acid” (claim 93).

In view of the above, each of the presently pending claims in this application is believed to be in immediate condition for allowance. Accordingly, the Examiner is respectfully requested to withdraw the outstanding rejection of the claims and to pass this application to issue.

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Respectfully submitted,

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**Version With Markings to Show Changes Made**

1. (Thrice Amended) [A composition for selectively etching a doped substance, said] An etching composition consisting essentially of:

a non-aqueous composition of an alcohol and at least two inorganic acids, wherein one of said inorganic acids is selected from the group consisting of hydrofluoric acid, phosphoric acid, sulfuric acid, boric acid, carbonic acid, perchloric acid and sulfurous acid.

2. (Amended) [A composition for selectively etching doped silicon, said] An etching composition consisting essentially of:

a non-aqueous composition of an alcohol and at least two different inorganic acids selected from the group consisting of hydrofluoric acid, phosphoric acid, sulfuric acid, boric acid, carbonic acid, perchloric acid and sulfurous acid.

82. (Twice Amended) [A composition for selectively etching a doped substance, said] An etching composition consisting essentially of:

a non-aqueous composition of isopropanol and at least two inorganic acids, wherein one of said inorganic acids is selected from the group consisting of hydrofluoric acid, phosphoric acid, sulfuric acid, boric acid, carbonic acid, perchloric acid and sulfurous acid.

83. (Twice Amended) [A composition for selectively etching a doped substance, said] An etching composition consisting essentially of:



a non-aqueous composition of propylene glycol and at least two inorganic acids, wherein one of said inorganic acids is selected from the group consisting of hydrofluoric acid, phosphoric acid, sulfuric acid, boric acid, carbonic acid, perchloric acid and sulfurous acid.